Appendices

1 Questionnaire

The following list of questions was the guideline for the interviews conducted in Jakarta, Indonesia during the month of April 2002. It has not always closely been followed and sometimes was not applied at all. However, it shows how the author proceeded in obtaining information from his interview partners used in this paper as primary sources.

Questionnaire on Wind Energy in Indonesia

Energy Market

1. To what extend does the Indonesian government's energy plan include renewable energies? *

2. Is there strategic consideration to reorganize the energy market due to restricted fossil energy supply in the future? *

3. Can you provide information on the power grid (voltage, capacity, length, etc.)? *

4. What are actual costs of supply of electricity and final consumer costs/prices? What part of the price is taxes? What should be added due to direct or indirect subsidies? *

5. Can I rely on data from the IEA and djlpe on electricity demand, consumption and production capacity and it's energy outlook for Indonesia?
   Would you recommend other sources?

6. What are the costs per kWh for electricity production with various fuels (oil, gas, gas-steam, coal, other renewables) without taxes and subsidies? *

7. What are the costs per kW for diesel generators (including investment, maintenance, fuel) for proposed operation of 20 years? *

Wind Energy

1. Do you have (sufficient) information on the wind regime in Indonesia? *

2. Do you have experience with former or recent Wind Energy projects? *

3. Can you provide information on plans (state, industry or private) for the use of wind energy in Indonesia? *

4. Do you know of specific plans of larger scale (several MW) projects?

5. What do you regard as the main incentives to enter (invest) into Wind Energy in Indonesia? (What circumstances may give Wind Energy a chance?)

6. What may be obstacles to introduce Wind Power in Indonesia?

7. Are there any obstacles of cultural kind to the introduction of Wind Power in Indonesia? (i.e. highth of wind turbines, rotation etc. may be in contrast to certain believes)

Liberalization

1. How can IPPs enter into the energy sector in Indonesia? *

2. (When) Will there be the possibility for IPPs of directly selling electricity to the consumer using existing infrastructure?

3. To what extend are or will be provinces and districts or even communities independent from Jakarta in their decisions on energy supply? *

4. Is a province, district, community allowed to organize it's power generation and distribution independently from PLN? *

5. What other changes will occur with the liberalization of the energy market? Within what time?

International Agreements

1. Where do I find substantive information on Indonesia's national sustainability strategy as prepared for the World Summit in Johannesburg this year – following the Rio Declaration of 1992. *

2. Will Indonesia ratify the UNFCCC and Kyoto Protocol and thereby officially enter into the CDM and JI procedures?

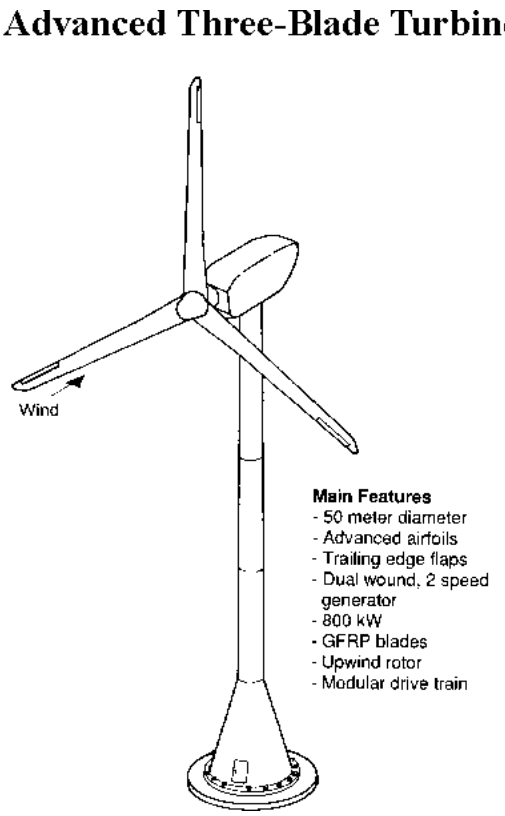
3. Is CDM a topic on Indonesia's political agenda? To whom and to what extend? *

*** Can you help me with printed English or German Information on any of the above topics?**

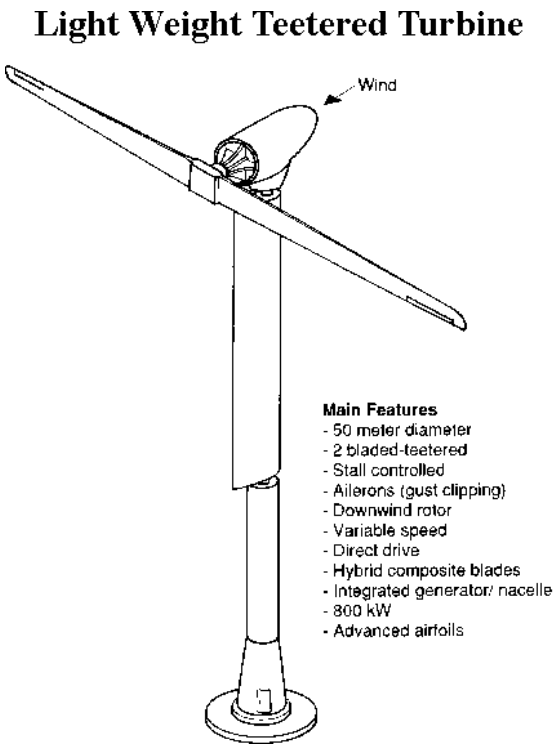
2 Different Types of Wind Turbine Generators

The author of this paper himself does not have a technological background. He had to study the various techniques of wind power applications himself for achieving a preliminary understanding of the technology. The drawings of the various types of WTGs are supposed to make the reader more comfortable with the subject of wind energy.

2.1 Three Bladed WTG



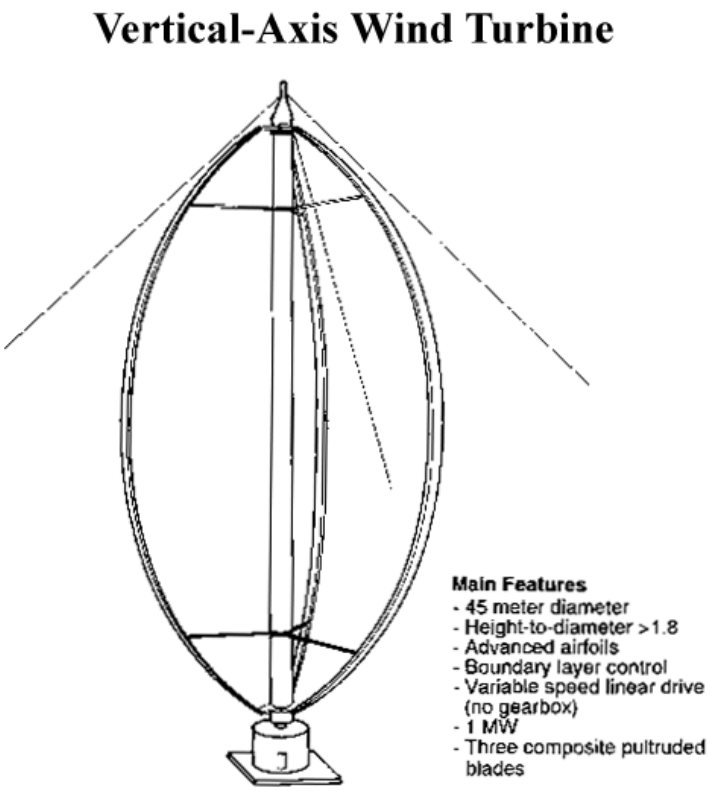
2.2 Two Bladed WTG



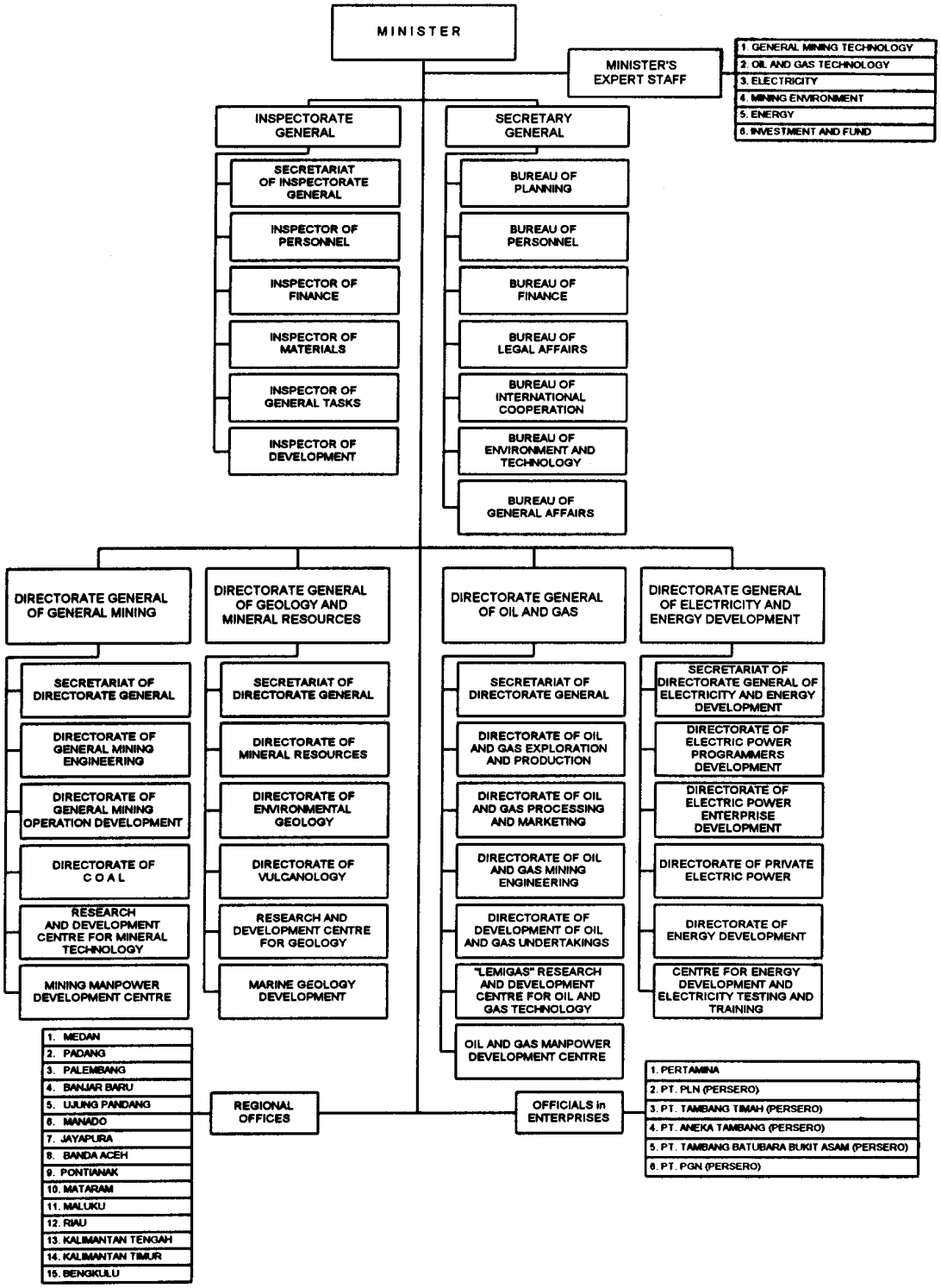
2.3 Savonius Type WTG

Savonius type WTGs have a vertical axis with usually four shovel-like blades. These are automatically always ‚in the wind', making complecated ‚yaw mechanisms' that keep horizontal WTGs in the direction of the wind unnecessary. Savonius type WTGs are easy to construct and need little maintenance. In Indonesia some exist for water pumping.

2.4 Darieus Type WTG

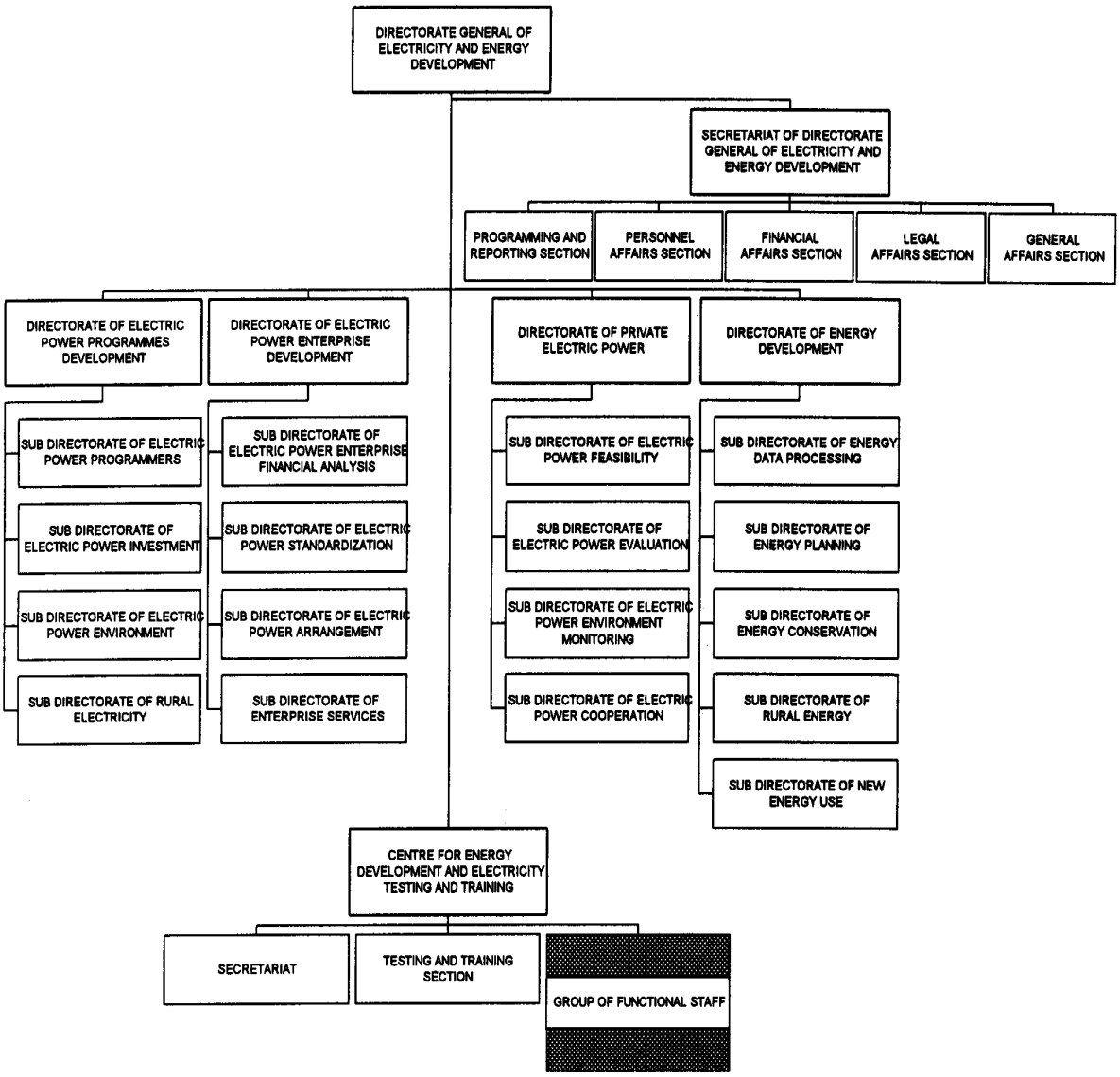


3 Organization Chart of the Ministry of Mines and Energy



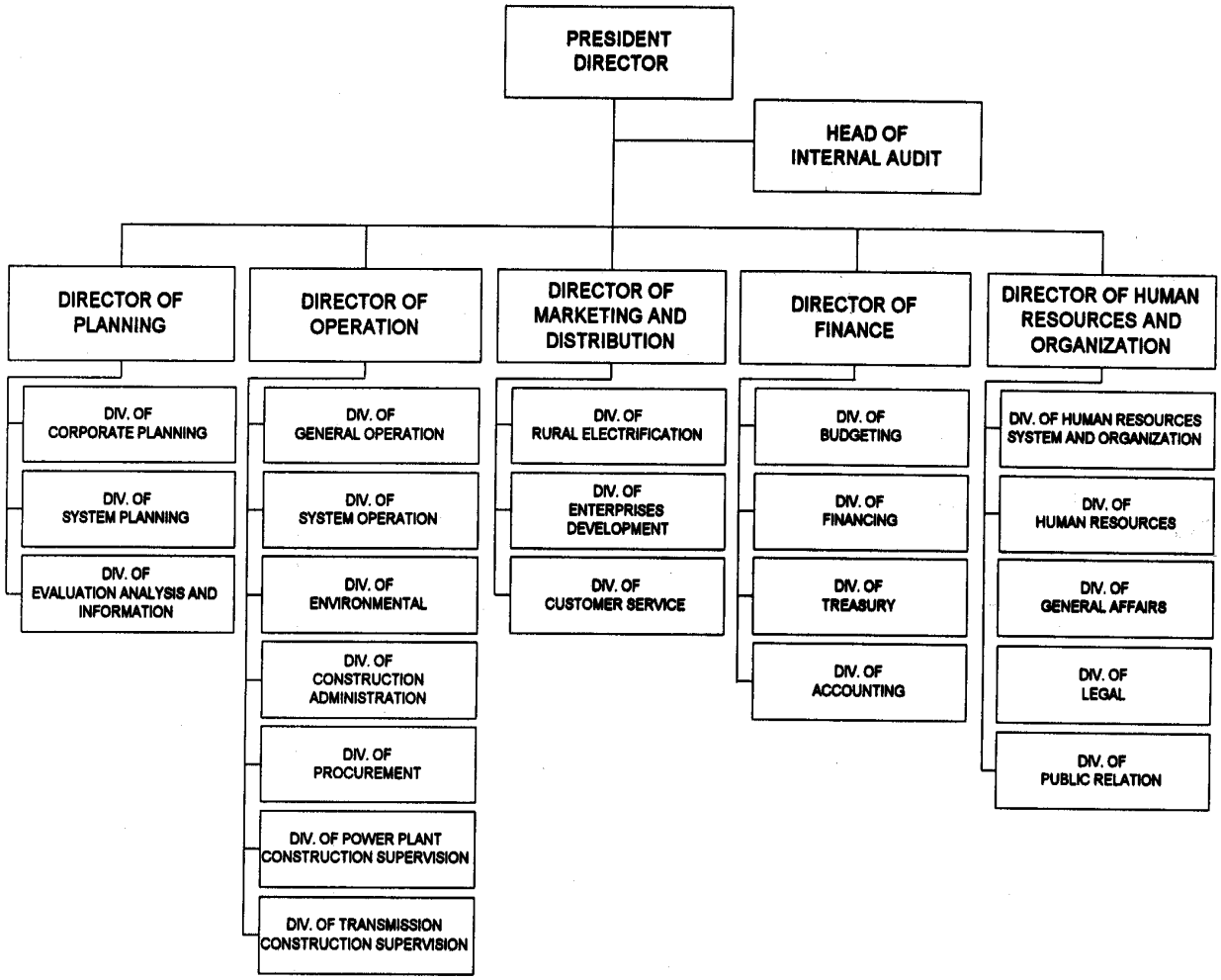
Source: Dalimi: 2001, p. 176.

4 Organization Chart of the Directorate General for Electricity and Energy Development (DGEED)



Source: Dalimi: 2001, p. 180.

5 Organization Chart of PT. Perusahaan Listrik Negara (PT. PLN)



Source: Dalimi: 2001, p. 182.

6 BMG Data on the Wind Regime

Badan Meteorologica dan Geofisika, the Agency for Meteorology and Geophysics runs some 70 meteorological stations throughout Indonesia. It constantly collects wind data.

6.1 1974 Wind Data

Station	Annual Average Wind Speed (m/s)	Mounthly Average Wind Speed (m/s)												max. speed (m/s)
		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Java														
Bandung	2.66	4.72	4.17	3.61	1.94	1.67	1.94	1.94	1.94	2.5	2.5	2.5	2.5	11.11
Jakarta (HP)	2.24	3.06	3.61	3.06	1.94	1.94	1.94	1.67	1.94	1.94	1.94	1.94	1.94	16.11
Madiun	6.04	7.78	4.17	4.72	4.17	5.28	6.67	7.78	6.67	7.78	6.67	6.67	4.17	14.72
Jakarta (K)	2.10	2.5	3.06	1.94	1.67	1.94	1.94	1.94	1.94	1.94	1.94	1.94	2.5	11.39
Semarang	4.33	6.11	5.28	5.28	5.28	4.17	4.17	4.17	3.61	4.17	3.61	3.06	3.06	11.39
Sumatra														
Banda Aceh	3.50	4.17	4.17	3.61	3.06	3.06	3.61	4.17	5.28	4.17	--	3.06	3.61	13.89
Bengkulu	1.60	1.67	1.67	1.67	1.67	1.11	1.67	1.11	1.11	1.11	1.94	1.94	2.5	11.39
Medan	3.13	3.61	3.61	4.72	3.61	2.5	3.06	3.06	2.5	3.06	3.06	3.06	1.67	9.17
Padang	2.18	1.67	2.5	2.5	1.94	1.94	1.94	2.5	1.94	2.5	2.5	2.5	1.67	16.67
Palembang	2.92	4.17	3.61	3.61	2.5	2.5	2.5	3.06	3.06	2.5	2.5	2.5	2.5	16.11
Pangkal Pinang	3.61	4.72	3.61	4.17	3.06	3.06	4.17	4.17	4.72	3.06	3.61	2.5	2.5	11.39
Nusa Tenggara & Bali														
Denpasar	4.33	6.67	5.28	4.17	1.94	4.72	5.28	4.17	4.72	5.28	4.72	2.5	2.5	16.11
Pasirpanjang	5.32	6.38	3.06	4.72	2.5	6.67	8.61	7.22	6.11	6.11	5.28	4.17	3.06	

Source: Djojodihardjo: 1979. Extended by Annual Average Wind Speed from Data.

6.2 1975 to 1989 Wind Data

Nr.	Ort	Jahr														
		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	Aceh	3,77	3,77	3,64	3,64	3,69		3,39	3,06	3,21	2,91	3,22	3,16	2,91	3,29	
2	Sabang		2,49	2,70	2,92	3,56	3,29	1,69	3,60	3,77	3,51	3,94	4,28	3,32	3,47	4,58
3	Belawan				3,34	3,26	1,40		1,66	1,54	1,16	1,37	1,41	1,08	1,18	1,17
4	Sitoli			2,19		2,19										
5	Sibolga	3,09	2,57	2,83	2,70	2,62		2,57	2,88	3,04	2,70	2,94	2,87	2,66	2,71	3,30
6	Polonia	4,12	2,62	2,49	2,40	2,44	2,74	0,87	1,93	2,01	1,65	2,48	3,18	3,08	3,26	3,30
7	Tabing	4,12	2,92	2,10	1,37	0,64	0,69		1,03	1,07	1,03	1,11	1,16	1,48	1,40	1,31
8	Palmerah	4,63	1,76	1,07	0,64	0,64	0,51	2,91	0,69		0,51	0,60	0,66			1,97
9	Sinkep		4,07	3,47	3,13	3,17	2,61	3,08	2,96	2,96	2,66	2,70		1,08		2,27
10	Rengat	4,63	1,84	1,33	0,94	2,36	2,43	3,66	1,84	2,66	2,24	2,78	2,36	2,28	2,62	2,27
11	T.Pinang		3,99	3,94	3,43	3,47	3,29	3,60	3,37	3,51	3,18	3,17	3,37	3,26	3,03	
12	Ranai			3,04	3,77	4,07	3,55	3,43	3,56	3,96	3,81	3,80	3,04	3,18	3,50	3,50
13	S.Tiga		3,00	3,00	3,39	3,52	3,41			3,71	3,60	3,80	4,37	3,38	3,28	3,21
14	T.Pandan		3,00		2,57	1,67		3,94	2,23	1,54	1,80	1,65	1,69	2,01		
15	P.Pinang	2,70		3,64	3,00	3,22	3,51	0,94	3,51	3,32	3,26	2,90	3,06	3,08	2,83	
16	Palembang	2,87	2,79		1,63	1,50	1,11	1,76		1,17						1,20
17	Bengkulu	2,96	3,47	2,79	1,80	1,59	1,74		2,52	2,63	2,17	3,08	3,22	2,63	1,29	
18	K.Setra	1,46		2,06	3,60	2,79		1,31	3,27	2,74	3,34	2,78	3,13	3,32	2,57	2,67
19	T.Karang	2,19	1,80	2,79	1,50	0,99	1,08	2,17	1,50	1,17	1,16	1,07	1,24	1,22	1,03	1,26
20	Curug	3,64	2,92	2,57	2,53	2,57	2,74	1,20	1,89	2,00	1,91	2,06	1,66	1,54	1,71	
21	Bandung	2,79	2,57	2,92	2,62	2,32	2,74		2,91	3,13	3,08	3,94	4,16	3,60	0,97	3,34
22	Jatiwangi	2,23	1,89	2,53	2,32	2,36		1,80		1,92		1,94	1,93	1,96	2,06	1,84
23	Kalijati				0,51	1,16	1,46		1,59	1,54		1,71	1,83	2,23	1,93	
24	P.Betung		2,70	2,06	1,67	1,84										
25	Serang	1,97	1,71	1,41	1,63	1,71			2,71	2,53	2,36	3,00	2,80	2,76	2,52	2,53

Measurements in m/s.

Source: Moeljono: 1998, p. 89.

1975 to 1989 Wind Data (continued)

Nr.	Ort	Jahr														
		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
26	Tasik	2,01	2,14	1,89	1,59	1,37		2,71	1,97	2,06		2,91	4,34	2,88		2,91
27	Halim P.	2,23	2,10	1,71	1,93	2,53	1,76		4,67	1,67	1,59	1,37	1,22	1,12	1,44	1,41
28	JKT. OB	2,40	2,66	2,49	2,01	1,93		2,76	1,59	0,56	1,03	1,54	1,50	2,01	1,94	1,80
29	Kemayoran	2,53	2,70	2,96	3,09	2,92	2,57	3,73	2,57	2,44		2,06				
30	T.Priok	1,63	4,20	3,94	4,54	2,62	3,37	2,11	3,77	4,76	4,70	4,01	5,54	3,68		5,76
31	Cilacap	3,22	3,39	2,66	2,27	2,27	1,94	2,31	2,57	1,82		3,73	2,48	3,64	2,74	
32	A.Yani	3,99	3,26	2,92	2,79	2,70	2,01	3,75	2,14	2,76	1,89	1,54	1,49	1,66	1,54	
33	Maritims	3,69	3,82	3,82	3,69	3,43	2,06		3,55	1,93	1,73	1,64	1,89	1,89	2,14	2,10
34	M P B	3,90	1,93	2,10	1,97	1,93										
35	A.Sumarno		2,49	1,84	1,11	2,36			2,83	2,57	2,66	2,52	2,99	3,51	3,21	2,91
36	Tegal	1,2	2,74	2,23	1,84	1,93			3,17	2,31		2,57	2,33	2,23	2,23	
37	Malang	1,59	1,93	2,14	2,01	1,41	3,31	1,84		1,94	3,34	3,34	4,81	3,91	4,47	3,13
38	Madiun	5,70	6,26	6,00	3,90	4,46	3,06	4,11	3,94	3,30		3,39	2,74	3,26	3,43	3,30
39	Kalianget	3,39	3,60	3,17	3,56	3,60	3,60	3,34	3,92	3,30		3,86	2,63	5,44	5,05	4,11
40	Bawean	2,44	3,17	2,70	2,19	2,40	2,40	3,08		3.43	2,17	2,78	2,62	3,31		
41	T.Perak	3,34	2,92	2,79	2,74	3,00			2,47	2,96	2,18	2,18	3,64	2,42	2,10	2,34
42	Selo			1,03	1,63	1,59			0,84	0,96	0,51	0,51	0,60			
43	A.Sucipto	2,36		1,84	1,67	1,63	1,31	2,17	3,51	3,75	4,02	3,91	3,97	3,79	3,06	2,57
44	Jogya	0,56		2,92		0,47				3,34						
45	Padio	2,32	2,44	2,19	2,19	1,07	0,94	1,09	1,11	2,38	2,48	2,40	1,07	2,27	1,03	1,03
46	Banjar M.		1,29	1,97		1,33	2,78	3,03	2,96	2,91	2,98	3,47	3,51	3,21	3,31	0,90
47	Balik P.	2,92	3,13	2,79	2,06	1,84	1,61	2,23	2,53		2,47	2,63	2,57	2,93		
48	Tarakan		0,77		1,03	1,80			3,04	2,76	1,54	1,14	1,92	2,09	2,16	2,83
49	P.Raya					1,33	2,06	2,57	4,67	2,48	2,36	2,44	2,57	2,48	2,31	1,71
50	Denpasar	3,56	3,69	3,56	2,32	3,00			2,85	2,53	2,74	2,53	2,47	2,83	2,52	

Measurements in m/s.

Source: Moeljono: 1998, p. 90.

1975 to 1989 Wind Data (continued)

Nr.	Ort	Jahr														
		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
51	H.Nudin	1,97	1,76	1,76	1,97	1,76	1,54	1,44	1,76	1,50	0,84	0,93	1,16	1,29	1,07	0,99
52	A.Sanjaya			2,70	1,67	1,59	1,85	1,29		1,47	1,63	1,65	1,54	1,67		1,54
53	M.Palu		2,83	2,44	2,23	2,01				2,57	2,71					
54	Bitung			3,00	3,17	2,87	2,53	2,34	2,71	3,08	2,20	2,38	2,62	3,77		
55	Gorontalo	2,27	1,76	1,71	1,46	1,93	1,29	1,33	2,21	1,75	1,46	1,40	1,54	2,10	2,00	1,46
56	Naha					2,27				1,93	1,71	1,80	2,01	2,40	2,18	2,31
57	S.Ratulangi			2,96	1,54	1,24			1,63							2,70
58	Kendari		1,59	2,96	2,57	2,96	3,98	2,83	3,08		2,57					
59	Ampenan						2,87	2,86	2,74	2,66	2,16	2,11	2,31	2,27	1,68	2,20
60	Sumbawa	2,83	3,82	4,20	3,69	3,90	3,90	4,11	4,46	4,33	3,19	3,08	2,31	2,01	2,06	1,84
61	Kupang	5,66	5,83	5,57	4,97	4,72	4,46	4,31	3,60	3,74	3,77	3,86	3,88	4,32	3,37	
62	Maumere			3,69	3,13	2,74	2,96	2,66	1,71	2,74	2,66	3,21	3,86	4,07		
63	Waingapu	2,83	3,94	3,39	3,04	2,70	3,37	3,60	3,51	3,68	3,37	3,41	3,08	2,71		
64	Ambon		1,71	2,01	1,54	2,06	1,63	1,61		2,80	1,07	1,68	1,59	1,96	1,66	1,84
65	Saumlaki			3,30	2,83	3,04	5,53		2,76	2,83		3,17	2,74	3,30	3,19	3,13
66	Tual		1,46	2,79	2,19	3,04	2,74	2,57	3,24	2,36	2,82	2,48	2,38	3,06	2,91	2,81
67	Ternate	2,79	3,30	3,26	3,30	3,26	3,43	3,32	3,73	3,04	2,62	2,74	3,21	3,31	2,80	2,66
68	Biak			1,67	2,36	2,23	2,06	2,36				3,01	2,74	2,80		2,57
69	Manokwari			1,33	2,53	2,96	2,48	2,80	3,00	3,08	2,68	2,90	2,91	2,68	2,83	
70	Dili			1,14	1,29	1,76	1,45	1,64	2,31	2,27	2,70	2,43	2,10	2,36	2,00	1,84

Measurements in m/s.

Source: Moeljono: 1998, p. 91.

6.3 1990 to 1995 Wind Data

No	Village/Sub District/Regency	Province	Year of Measurement	Average Velocity at Elevation of 24 m
1	Sabang	Aceh	1994	2.73
2	Meulaboh	Aceh	1994	3.33
3	Polonia Medan	North Sumatera	1994	3.68
4	Sei Dadap Kisaran	North Sumatera	1994	3.06
5	Binaka	North Sumatera	1994	3.06
6	Sicincin	West Sumatera	1994	3.86
7	KP. Laing	West Sumatera	1992	3.72
8	Depati Darbo	Jambi	1994	4.01
9	Simpang Tiga Pakanbaru	Riau	1994	3.97
10	Kijang	Riau	1994	4.22
11	Japura Rengat	Riau	1994	2.83
12	Ranai	Riau	1994	2.45
13	Pangkal Pinang	South Sumatera	1992	3.68
14	Buluh Tumbang Tanjung Pandan	South Sumatera	1995	5.56
15	Serang Banten	West Java	1992	3.01
16	Curug Tangerang	West Java	1994	2.70
17	Tanjung Priok	Jakarta	1993	4.45
18	Cengkareng	Jakarta	1994	3.55
19	Semarang Maritim	Central Java	1992	2.94
20	Kledung	Central Java	1994	4.08
21	Adi Sumarmo Surakarta	Central Java	1995	2.39
22	Iswahyudi Madiun	East Java	1994	5.57
23	Suranaya AURI	East Java	1994	4.65
24	Surabaya Perak	East Java	1994	2.61
25	Kalianget	East Java	1994	5.40
26	Sangkapura Bawean	East Java	1994	2.96
27	Surabaya Maritim	East Java	1994	3.37
28	Ploso	East Java	1991	2.39
29	Kp. Tiekung	East Java	1994	2.55
30	Denpasar	Bali	1992	2.39

Measurements in m/s.

Source: Dalimi: 2001, p. 28.

1990 to 1995 Wind Data (continued)

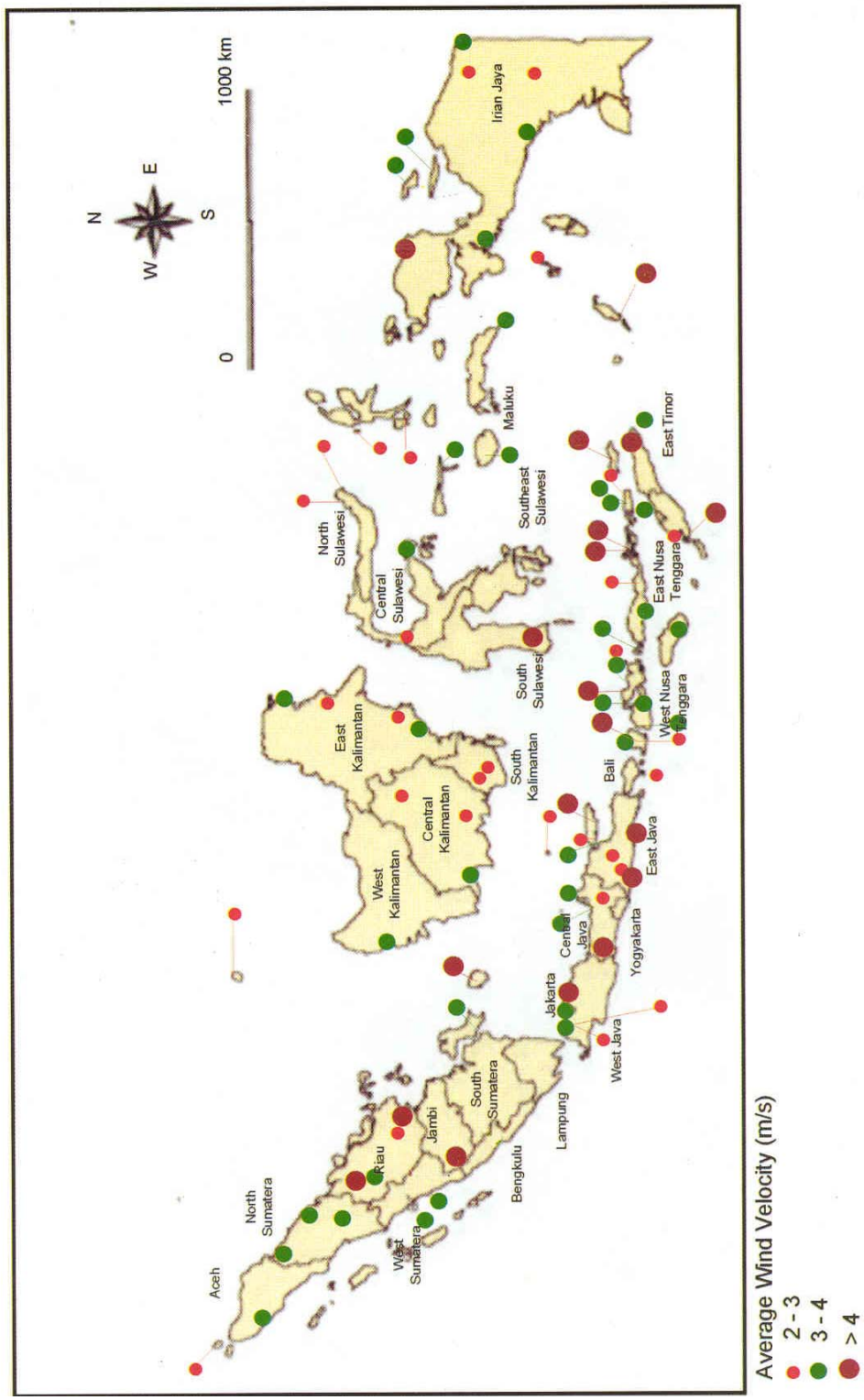
No.	Village/Sub District/Regency	Province	Year of measurement	Average Velocity at Elevation of 24 m
1	Banjar Baru	South Kalimantan	1994	2.55
2	Balik Papan	East Kalimantan	1994	3.49
3	Tarakan	East Kalimantan	1994	3.06
4	Tanjung Redep	East Kalimantan	1994	2.58
5	Palangkaraya Panarung	Central Kalimantan	1994	2.96
6	Muara Teweh	Central Kalimantan	1994	2.95
7	Pangkalan Bun	Central Kalimantan	1994	3.01
8	Pangkalan Bun	Central Kalimantan	1994	3.01
9	Bubung Luwuk	South East Sulawesi	1994	3.01
10	Samratulangi Menado	North Sulawesi	1994	3.21
11	Meteo Bitung	North Sulawesi	1994	2.80
12	Rembiga Ampenen	West Nusa Tenggara	1994	3.14
13	Sengkol	West Nusa Tenggara	1991	2.45
14	Sumbawa Besar	West Nusa Tenggara	1994	3.92
15	Bima	West Nusa Tenggara	1994	2.83
16	Kupang	East Nusa Tenggara	1994	5.51
17	Maumere	East Nusa Tenggara	1994	3.46
18	Lasiana	East Nusa Tenggara	1994	3.62
19	Lekunik	East Nusa Tenggara	1994	3.93
20	Tardamu	East Nusa Tenggara	1994	5.11
21	Satar Tacik Ruteng	East Nusa Tenggara	1994	3.88
22	Ternate	Maluku	1994	2.90
23	Tual	Maluku	1994	2.70
24	Saumlaki	Maluku	1994	4.72
25	Geser	Maluku	1994	3.37
26	Sanana	Maluku	1994	3.01
27	Na,lea	Maluku	1994	3.86
28	Labuha	Maluku	1994	2.62
29	Genyem	Irian Jaya	1992	2.89
30	Biak	Irian Jaya	1994	3.81
31	Kaimana	Irian Jaya	1994	3.80
32	Manokwari	Irian Jaya	1994	4.21
33	Sentani	Irian Jaya	1994	3.18
34	Serui	Irian Jaya	1990	3.42
35	Wamena	Irian Jaya	1990	2.96
36	Timika	Irian Jaya	1994	3.06
37	Dilli	East Timor	1995	3.68
38	Bau Cau	East Timor	1995	4.28
39	Komoro	East Timor	1995	2.45
40	Oe Cusie	East Timor	1995	2.57

Measurements in m/s.

Source: Dalimi: 2001, p. 29.

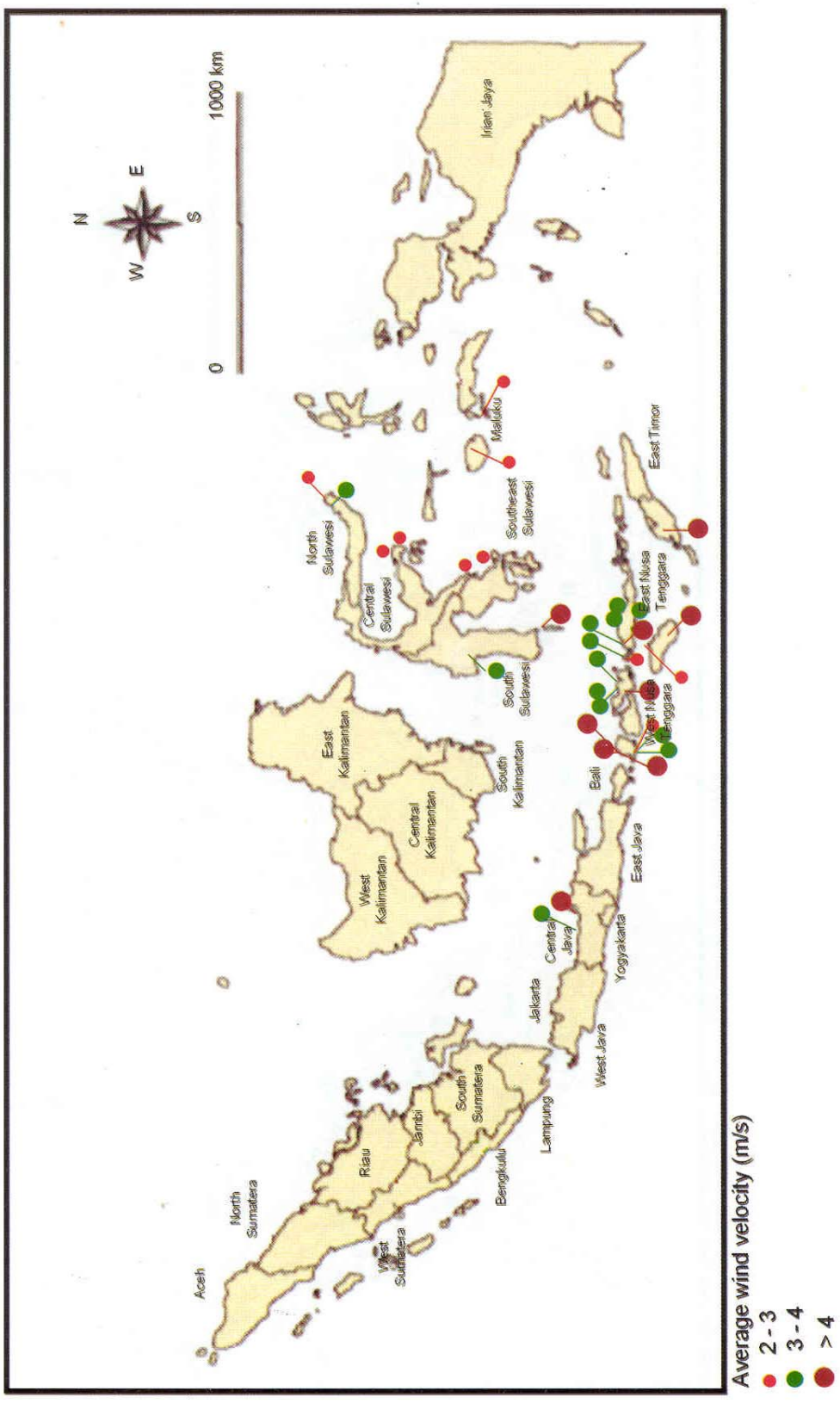
7 Maps on the Wind Regime

7.1 BMG Data of Wind Velocity at 24m



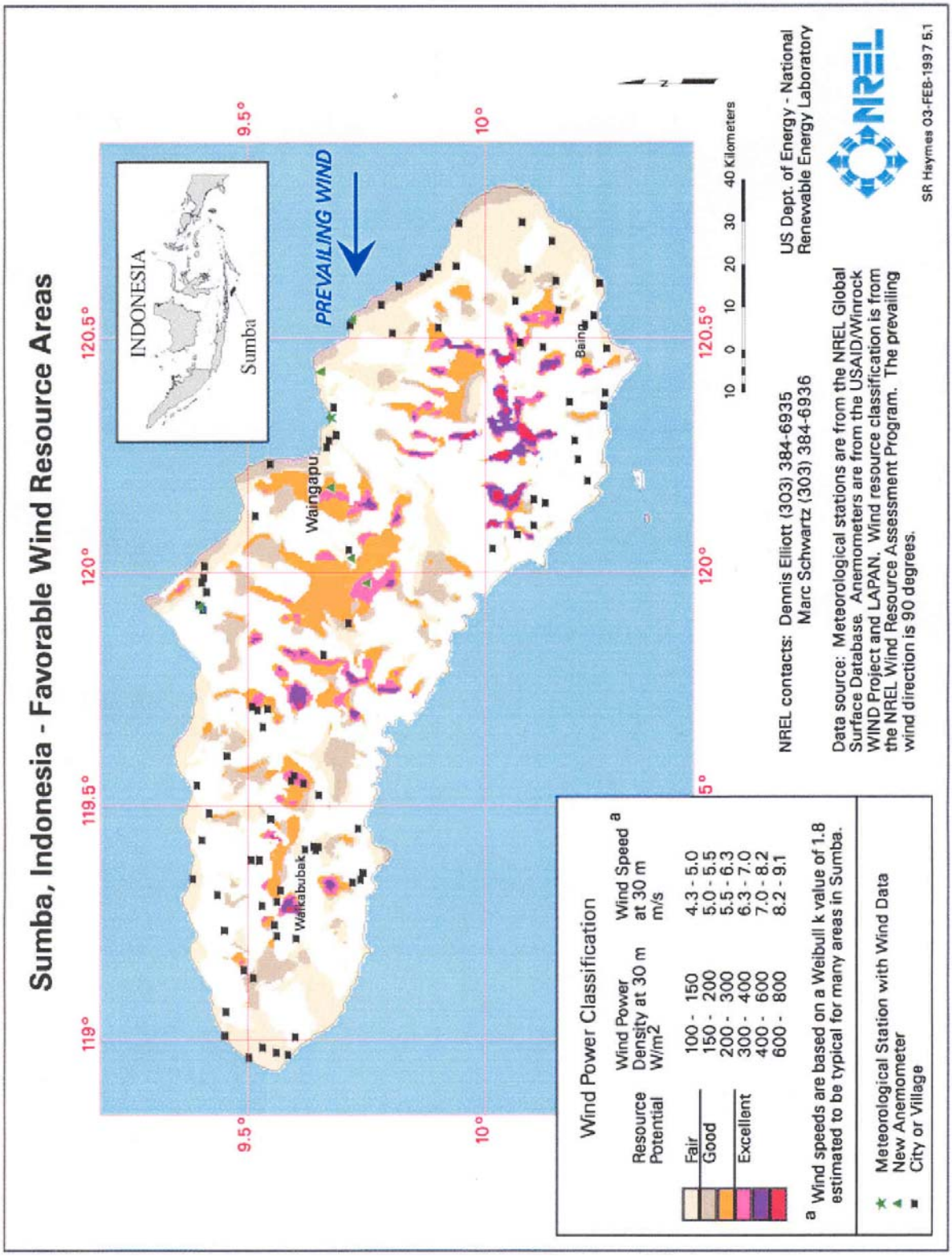
Source: Dalimi: 2001, p. 166.

7.2 LAPAN Data of Wind Velocity at 24m



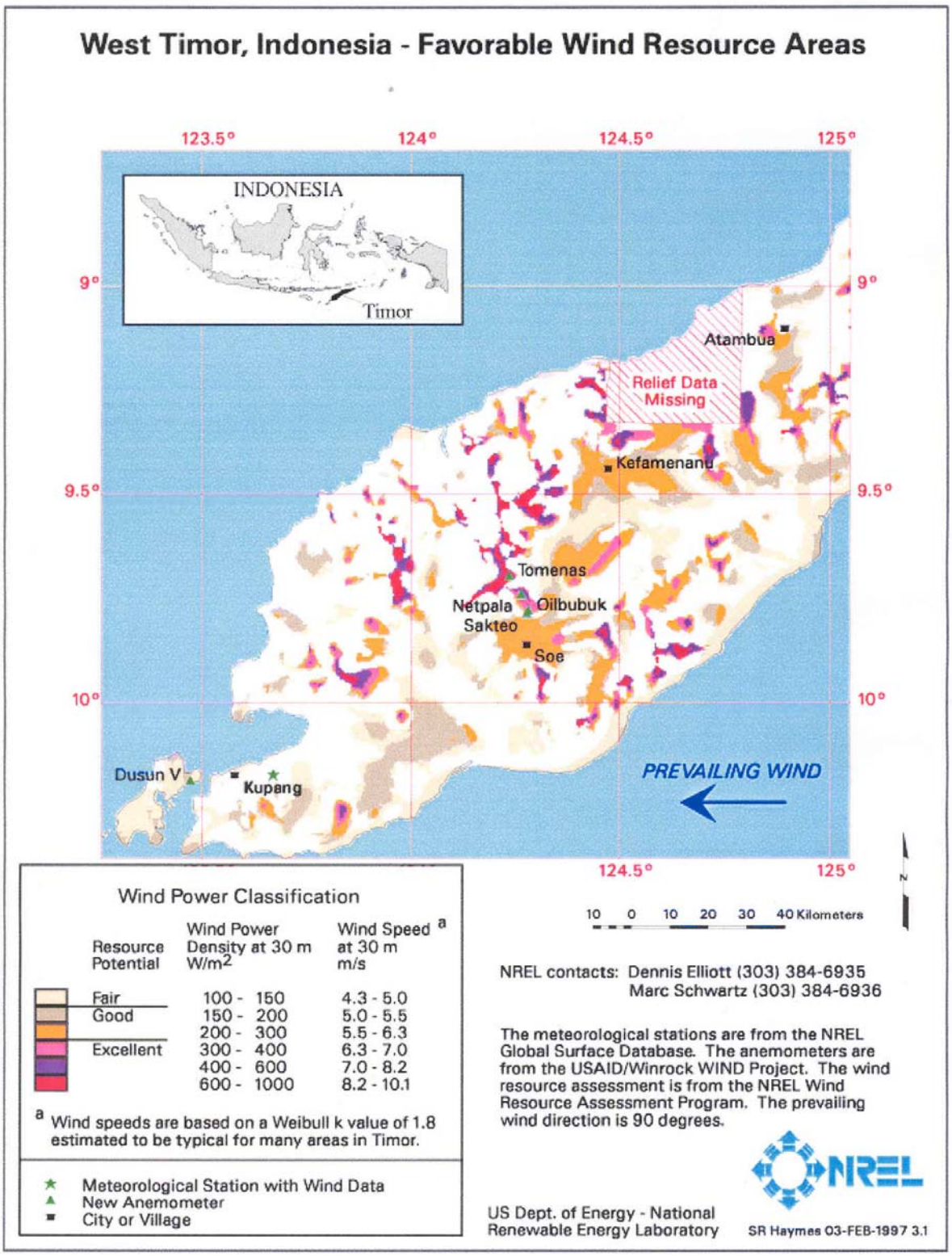
Source: Dalimi: 2001, p. 166.

7.3 NREL - Sumba



Source: National Renewable Energy Laboratory.

7.4 NREL – West Timor



Source: National Renewable Energy Laboratory.